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MONTHLY LETTER REPORT

ON

IMAGE ANALYSIS III

[redacted]

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SEPTEMBER 1, 1968 TO OCTOBER 1, 1968

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Reg # 18299

MONTHLY LETTER REPORT

ON

IMAGE ANALYSIS III

I. WIENER FILTERING

A. THE IDT

The computer program for determining the optimum Wiener shaded aperture has been completed and satisfactorily tested.

The analysis of Wiener filtering in the scanning aperture plane of a microdensitometer has begun. Experiments using Tri-X film have been designed, the data collected and the results analyzed.

The form of the Wiener filter is given by

$$H(\omega) = \frac{\Phi_{SS}(\omega)\ T(\omega)}{\Phi_{SS}(\omega)\left|T(\omega)\right|^2 + \Phi_{NN}(\omega)}$$

where $H(\omega)$ is the Wiener filter, $T(\omega)$ is the transfer function of the taking system, $\Phi_{SS}(\omega)$ the Wiener spectrum of the signal and $\Phi_{NN}(\omega)$ the Wiener spectrum of the noise. In this expression we chose to use for $T(\omega)$ the transfer function of Tri-X film developed in D-76 for objects contact printed onto Tri-X. The first experiment was designed to see if the detection of a grain-limited low contrast circular object could be improved and $\Phi_{SS}(\omega)$ was chosen to represent this object.

The resulting microdensitometer traces obtained from scanning across a circular object with a Wiener shaded aperture and a clear aperture of comparable size revealed the suppression of high frequency noise with a corresponding retention of signal. This increased the signal-to-noise ratio. The IDT traces revealed the preceding in a two-dimensional form.

In calculating the Wiener filter for scanning over a sector target, a problem arose in determining its Wiener spectrum. It was approximated to be a circular object whose transform cut off at approximately the cutoff of the Wiener spectrum of the noise. This criterion was used since it seems reasonable that a piece of photographic film cannot hold any signal frequencies higher than those frequencies possessed by the grain noise. Apertures were made and the results revealed a decrease in high-frequency noise with a corresponding 20 to 30% increase in resolution.

B. THE MICROSCOPE

Experiments were conducted with the microscope using the Wiener filter designed for the sector target and Tri-X film. Using the sector target as an object, this produced results comparable to those previously obtained with the Gaussian filter, that is, an apparent contrast increase and a highly noticeable smoothing of the grain noise. This filter was also used to investigate whether printing which is barely readable due to grain can be more easily read. In this case, the filter cannot be simultaneously optimized for all letters of the alphabet, but the sector target filter seemed like a reasonable choice since printing, like the sector target, consists of opaque lines on a clear background with all orientations represented. These experiments showed a definite improvement in the readability of the printing in cases where the printing was readable even without filtering. Results in the case where the printing was not readable without filtering are inconclusive. There is some indication that filtering enables a good educated guess to be made as to what certain words are, but this is highly subjective thus far, and needs further investigation.

II. SPATIAL FILTERING IN SCANNING SYSTEMS

Initial experiments using He-Ne laser illumination in a modified Joyce-Loebl microdensitometer have been conducted. In these experiments, all the condenser optics were removed and the sample was illuminated directly by the narrow collimated laser beam. The standard tungsten source was used for the reference beam illumination. The initial experiments were designed to evaluate the laser illuminated microdensitometer. Several conclusions have been reached.

1. Traces made with the laser illuminated microdensitometer are not as reproducible as those made with the normal instrument. This is apparently due to the fact that the sample and reference beams are derived from different sources, and can be alleviated by deriving the reference beam from the laser. This can be done by a relatively simple modification of the present equipment.

2. There are noticeable differences between the traces when an object is traced with the laser illuminated microdensitometer and a standard microdensitometer. These differences are apparently due to the increased coherence of the laser illumination.

While the differences between the traces are not large, they do point out the necessity for considering such a system to be nonlinear.

3. An encouraging result is the apparent absence of coherence noise in the laser illuminated traces. One advantage of doing coherent spatial filtering in a scanning system of this type is that the optical system, and thus the pattern of noise due to dirt and multiple reflections, is stationary and will not affect the trace. In these experiments, the objects were held in a glass sandwich which also moved as the object moved, so part of the noise pattern was possibly not stationary. In future work, the film being scanned will be held in a metal sandwich with a clear aperture around the area being scanned.

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PROGRESS REPORT NO. 3

PROJECT 6607

Period: September 1 through September 30, 1968

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Contract Status Report No. 3

PROGRESS DURING THE PERIOD

The exposure of all test material to be used in the remainder of the project was completed during the previous period. Six sets of replicate data were generated at approximately the 85 lines/mm resolution level, and another six sets at a performance level of about 60 lines/mm. This material is to be spray processed using operational methods. It is expected that this material will be available for initiating the data reduction and analysis phases of the program by the middle of the next reporting period.

PROBLEM AREAS

The only significant problem to date has been the lack of availability of an accurate comparator to permit making an adequate number of readings. This problem has been resolved, and a suitable machine will become available in the third week of the next reporting period.

WORK PLANNED FOR NEXT PERIOD

The reading and analysis of the first set of replicate will be initiated during the next reporting period. By the end of the next period, it will be possible to make an accurate estimate of the time required to finish the reading of all the data.

WORK SCHEDULE

We estimate that at this point the work is three weeks behind the original schedule.

PERSONNEL

No changes have been made in the personnel assigned to this program.